

OBSERVATIONS ON THE VEGETATION OF CHIHUAHUA

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The state of Chihuahua lies in the northwestern corner of the central table land of Mexico. Its location, size and physical features make it an area of importance in connection with the plant and animal geography of the southwestern United States, as well as in the investigation of the relations between the Sonoran and Chihuahuan deserts.

Knowledge of the flora of Chihuahua is based mainly upon collections made by some fourteen men,¹ and information regarding it is scattered through scores of publications over a period of sixty years. There is no check list or manual covering any part of the state. On the character and distribution of the vegetation only a few pages have been written and these with reference to the northern border. In many publications on other topics the plants have received occasional mention. Several men have mapped the vegetation of North America or of Mexico with little to guide them in reference to the Chihuahuan region. Knowledge of the fauna and ecological features of the animal life is in a very similar condition.

Brand (1) has published a map of the vegetation of northwestern Mexico, recognizing five types in Chihuahua. He makes no reference to the grassland and publishes no descriptions of the regions indicated on his map. In a later paper Brand (2) has described the land forms of the highlands of Chihuahua north of Ciudad Guerrero, with brief notes on the vegetation and some helpful illustrations and climatic tables.

The dearth of botanical information about Chihuahua has prompted the publication of the following brief sketch of the state, based on a trip made in the summer of 1937, on which all parts were visited except the oak forest and barrancas of the extreme southwestern corner. The writer was accompanied by Dr. L. R. Dice, of the University of Michigan, and Dr. T. D. Mallery, of the Desert Laboratory of the Carnegie Institution, to both of whom he is indebted for helpful discussion of the conditions encountered.

PHYSIOGRAPHY

Five rather clearly defined physiographic regions may be recognized in Chihuahua. These are the bajadas and low mountains of the northeast and east, the enclosed basins of the northwest and southeast, the elevated plains of the central district, the Sierra Madre Occidental, and the barrancas, or canyons of the Pacific slope of the Sierra Madre.

¹ Wislizenius, Gregg, Schaffner, Wilkinson, Pringle, Palmer, Nelson, Rose, Hartman and Lloyd, Townsend and Barber, Hitchcock, and Le Seuer.

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THE BAJADA REGION. This part of the state borders the Rio Grande and the lower course of its only important Chihuahuan tributary, the Rio Conchos. The elevation varies from 800 to 1450 meters (2700 to 4750 feet). Gently falling bajadas and broad intermont plains occupy a high percentage of the region. Extensive limestone areas present the usual surface features of that material, being either hilly and broken or else rolling or nearly level, with little evidence of erosion and transport. The mountains of this region probably occupy from 5 per cent to 8 per cent of the total area.

THE ENCLOSED BASIN REGION. The largest enclosed basins, or bolsons, lie in the north and the extreme southeast, at elevations from 1175 meters (3850 feet) in the former area to 1400 meters (4600 feet) in the latter. There are also numerous smaller basins in the midst of the Bajada Region as well as in the Elevated Plains Region. On the north three large lake beds, or playas, Laguna de Guzman, Laguna de Santa Maria and Laguna de Patos, receive the flood waters of rivers which drain the north end of the Elevated Plains Region. These rivers are fed by heavy summer rains and fall at a steep gradient, conditions which have enabled them to cut into the old deposits of mountain outwash and to carry sand through to their terminal playas. During the dry seasons water sometimes disappears from the lake beds and the deposits of sand are blown for distances of as much as 80 to 100 kilometers (50 to 60 miles). Part of northern Chihuahua is a vast dune complex and has a surface shaped almost wholly by the wind. The failure of the three tributaries of the largest playas to deliver their flood waters to the Rio Grande is apparently due to the accumulation of their loads between the playas and the Rio Grande.

The enclosed basins in the southeast, as well as the smaller ones in the central districts, are of structural origin. They are fed only by short streamways and floods from the torrential rains of the desert lowlands. Their playas are therefore built of fine alluvium rather than sand and have a high salt content. Under these conditions the action of the wind is confined to the daily agitation of the superficial alkaline dust through local spiral movements. Groups of white "tornillos" rise constantly during the daytime in slowly coiling columns to a height of 80 to 100 meters and circle majestically about the playa and its edges. The effects of wind are therefore slight, leaving the surface essentially as determined by the agency of water.

The drainage of extreme southeastern Chihuahua and the neighboring part of Coahuila runs into a large number of separate basins, which have either a central playa, if their catchment area is large, or a grass-covered floor, if their drainage area is small or wholly in the arid lowlands.

THE ELEVATED PLAINS REGION. This feature of Chihuahua forms a belt along the eastern base of the Sierra Madre which

varies from 25 to 110 kilometers (15 to 65 miles) in width. Elevations in the Plains Region range from 1600 to 2100 meters (5250 to 7000 feet). Their surface is dotted with numerous small mountains and their eastern edge is supported by a series of barrier ranges which have a basal elevation about 600 meters (2000 feet) higher on the west than on the east. The Plains are composed of thoroughly disintegrated outwash material derived from the ancient degradation of the Sierra Madre. On the east the present level of the Plains is being effectively maintained by the barrier ranges. In the north, however, the surface is being attacked by the three rivers which feed the northern basins, and on the west the Rio Papigochic, a tributary of the Yaqui, has eaten back into the Plains far east of the continental divide.

THE SIERRA MADRE REGION. The Sierra Madre Occidental lies in a north northwest-south southeast position and forms the continental divide, as well as the boundary between Chihuahua and Sonora. It consists of a broad series of ridges and mesas with summit elevations of 2500 to 2900 meters (8200 to 9500 feet), but at least three unexplored summits are believed to exceed 3500 meters (10,000 feet). The ridges are maturely worn and there are innumerable parks, meadows and flood plains with heavy accumulations of alluvium. There are large areas in the midst of which are no abrupt changes of elevation of more than 100 to 150 meters. The northernmost forested elevation is the Sierra de la Espejuela, 80 kilometers (50 miles) south of the International Boundary. With a single break at Carretas Pass, immediately south of this mountain, the Sierra Madre lies continuously above 2150 meters (7000 feet) for 800 kilometers (500 miles) to the south.

THE BARRANCA REGION. A small part of the Pacific slope of the Sierra Madre is comprised in this region, which lies partly in the states of Sonora and Sinaloa. Here are the evidences of the active cutting which has taken place since the last uplift of the Sierra Madre. Deep well-watered canyons with steep slopes have eaten far back into the mountains and in many places have isolated former portions of the Sierra or its subsidiary ranges. The Barranca Region is thus given an extremely irregular configuration and is confined to narrow bands and small areas. The fall from the western edge of the mature summit of the Sierra at 2150 meters (7000 feet) to the foothills of Sonora at 200 to 500 meters (650 to 1650 feet) takes place within a distance of 45 to 80 kilometers (28 to 50 miles).

VEGETATION

The distribution of the types of vegetation which clothe Chihuahua is found to run closely parallel to that of the physiographic provinces which have just been described. On the accompanying map (text fig. 1) are shown the approximate boun-

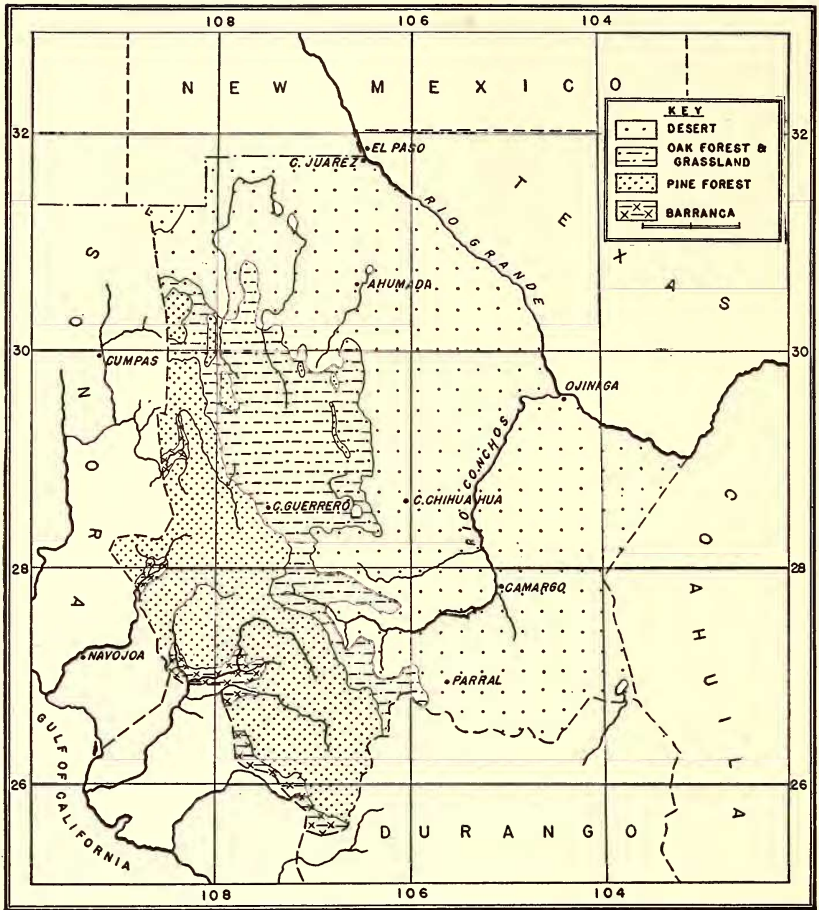


FIG. 1. Distribution of types of vegetation in Chihuahua.

daries of desert, coinciding with the Bajada Region and the Enclosed Basin Region; of grassland and oak forest, covering the Elevated Plains Region and the lesser mountains; of pine forest, clothing the Sierra Madre Region; and of oak and broad-leaf forest filling the Barranca Region. These types of vegetation are clearly distinct except for the existence of intermediate areas between the desert and grassland and some intermingling of oaks and pines.

DESERT. In the north and east Chihuahua is occupied by an unbroken stretch of desert which covers about 60 per cent of the state. It is a region of broad plains, long bajadas and large basins with widely spaced ranges of low mountains. There are many opportunities to travel for 150 to 300 kilometers (100 to

200 miles) without encountering substantial differences in the vegetation. Nevertheless there are marked differences between the widely separated parts of the area. The most distinct types of desert vegetation are those found in the sandy basins and dune region of the north, the bajadas and outwash plains of the northeast, the volcanic and limestone mountains of the northeast and east, the limestone plains of the south, and the bolsons of the southeast.

In the dune region a high percentage of the surface is wholly or partly stabilized but is covered by a very open stand of plants. There are local areas of the light cream colored sand which are in active movement, as well as numerous massive dunes almost wholly without plants. All of the features of dune development and plant succession which have been so adequately described by many workers are here exemplified on a large scale. The stabilized areas have a very open stand of *Prosopis glandulosa*, *Artemisia filifolia*, *Poliomintha incana*, *Ephedra Torreyana*, *Dalea scoparia*, *Hymenoclea monogyra*, *Atriplex canescens*, *Leiostemon Thurberi* and *Yucca elata*. Cacti are very uncommon and represented almost wholly by low platyopuntias. The most characteristic small perennials are:

<i>Croton neomexicanus</i>	<i>Coldenia hispidissima</i>
<i>Riddelia Cooperi</i>	<i>Melampodium leucanthum</i>
<i>Heliotropium Greggii</i>	<i>Sporobolus flexuosus</i>
<i>Bahia absinthifolia</i>	<i>Wislizenia refracta</i>
<i>Sphaeralcea incana</i>	<i>Palafoxia linearis</i>
<i>Euphorbia Parryi</i>	

The bajadas and outwash plains occupy a larger area in Chihuahua than any other type of desert, covering the sector which lies between lines drawn north and east from Chihuahua City. Their vegetation is very uniform in physiognomy and very simple in composition. It is strongly dominated by *Larrea*, which is often nearly pure, or elsewhere associated with *Flourensia cernua* where the soil is thin or with *Prosopis glandulosa* where the soil is deep. In the lowest part of each basin or valley *Prosopis* is dominant as a shrub of 1 to 2 meters with its trunk buried and its branches radiating from a hummock of soil.

On the bajadas there are only a few large perennials associated with the three that have been mentioned, and none that are abundant. The important ones are:

<i>Koeberlinia spinosa</i>	<i>Opuntia macrocentra</i>
<i>Acacia Greggii</i>	<i>Coldenia Greggii</i>
<i>Condalia spathulata</i>	<i>Opuntia imbricata</i>
<i>Celtis pallida</i>	<i>Acacia vernicosa</i>
<i>Condalia lycioides</i>	<i>Microrhamnus ericoides</i>

On the higher parts of the bajadas, on the pediments surrounding the mountains and on the hills and mountain slopes the

vegetation is much more diversified (pl. 1, fig. 1). *Larrea* loses its dominance although it does not disappear, and all of the associates just listed become more abundant. The most conspicuous plants are *Dasyilirion Wheeleri*, *Fouquieria splendens*, *Opuntia imbricata* and the massive *Yucca macrocarpa*. The most abundant plants are *Agave Lechuguilla*, *Coldenia Greggii*, *Euphorbia anti-syphilitica*, *Parthenium incanum* and *Jatropha spathulata*. The conspicuous plants are particularly abundant at the foot of mountain slopes and on the pediments. On gentler slopes, especially on limestone, the larger plants give way to the small but abundant ones. The only conspicuous cacti are *Opuntia imbricata*, reaching a height of 1 to 2 meters and *O. macrocentra*, which is here an erect plant but rarely exceeds 1 meter. Smaller cacti are, however, an important element in the vegetation, being chiefly represented by *Echinocactus horizionthalonius*, *Echinocereus dasycanthus*, *E. stramineus*, *Coryphantha macromeris*, *Escobaria tuberculosa*, and *Thelocactus bicolor*.

Along the small drainageways of the desert there is a slight increase in density on the part of *Prosopis*, *Acacia*, *Celtis* and *Condalia spathulata*, but no considerable increase in height. Only along the largest arroyos are there any trees in the desert sense of woody plants with one or several trunks, branching from the ground level, and reaching a height of 5 to 6 meters. In addition to larger individuals of *Prosopis* will be found *Rhus choriophylla*, *Berberis trifoliata*, *Porlieria angustifolia*, *Chilopsis linearis*, *Celtis pallida*, and *Acacia paucispina*.

The enclosed basins, or bolsons, of southeastern Chihuahua are part of a large region of similar character which extends into the neighboring states of Coahuila and Durango. Here the mountains are low and very widely spaced and the drainage is shallow and vacillating. Nearly level plains from 30 to 80 kilometers (20 to 50 miles) in width present very uniform conditions. The elevation is from 1200 to 1500 meters (4000 to 5000 feet). The soil is light gray and of fine texture. The vegetation is low, sparse and monotonous. In the higher basins the floor is covered by pure stands of *Hilaria*, in the lower ones the dominant plants are *Larrea*, *Acacia vernicosa* and *Flourensia cernua*, constantly varying from place to place in their relative abundance. *Prosopis* and *Atriplex canescens* are also locally abundant as well as sparingly represented throughout the plains. Less common are *Celtis pallida*, *Condalia lycioides*, *Koerberlinia spinosa*, *Buddleia scor-dioides*, and *Lippia Wrightii*. Cacti are uncommon and represented only by *Opuntia Kleiniae*, *O. macrocentra*, *O. leptocaulis* and *Echinocereus conglomeratus*.

South of Saucillo the Rio Conchos and the Rio Florido form the western boundary of the bolson region. West of this boundary is a rolling limestone plain which extends south nearly as far as Parral and rises toward the west. The elevation of the



FIGURE 1

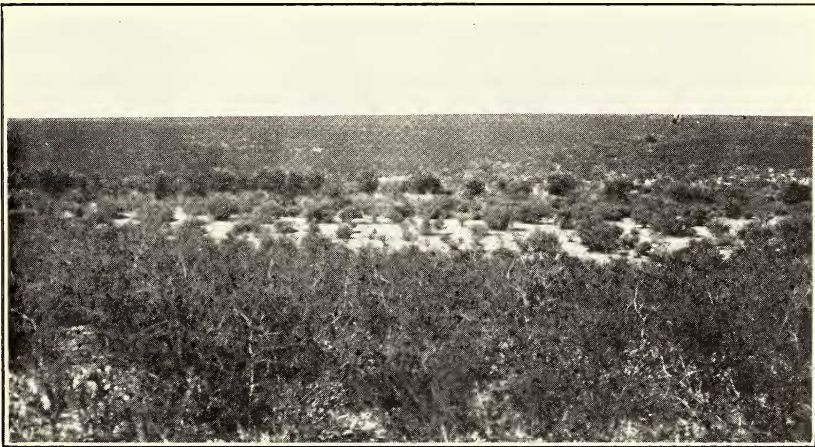


FIGURE 2

PLATE I. VEGETATION OF CHIHUAHUA. Fig. 1. Vegetation on outwash slopes of Sierra Tasajera in northeastern Chihuahua at 1600 meters elevation: dominant plants, *Yucca macrocarpa*, *Dasyllirion Wheeleri*, *Agave Lechuguilla*, *Coldenia Greggii*, *Lippia Wrightii* and *Hilaria mutica*. Fig. 2. Limestone plains west of Boquillas, in southern Chihuahua at 1400 meters elevation: vegetation a low closed stand of *Acacia vernicosa* and *Larrea tridentata*. In the depression: *Celtis reticulata*, *Condalia spathulata* and *Condalia lycioides*.

plain varies from 1150 to 1375 meters (3800 to 4500 feet). The surface has both shallow and deeply cut drainageways, as well as many large and small depressions which have no surface outlet. The shallow drainageways and the large depressions have a deep clay soil which is commonly a very dark gray. A high percentage of the region has a soil which is very shallow or confined to irregular pockets in the surface of the limestone.

The vegetation of the thin soil of the limestone plains is a dense stand of shrubbery which rarely exceeds 1 meter in height (pl. 1, fig. 2). *Acacia vernicosa* is strongly dominant, with *Larrea* and *Flourensia* forming less than 15 per cent of the stand. Plants of secondary importance are few and infrequent, including:

<i>Celtis pallida</i>	<i>Rhus microphylla</i>
<i>Condalia spathulata</i>	<i>Leucophyllum laevigatum</i>
<i>Agave Lechuguilla</i>	<i>Opuntia macrocentra</i>
<i>Opuntia Engelmannii</i>	<i>Koeberlinia spinosa</i>

On the slightly deeper soil surrounding the depressions *Larrea* and *Flourensia* become more abundant than *Acacia vernicosa*, and nearly pure stands of *Flourensia* are frequently seen. In the depressions, which are in some cases from 10 to 15 kilometers in width, there are no shrubs and the prevailing vegetation is a very open sod of *Hilaria mutica*.

The western edge of the limestone plains was crossed at only one locality and the configuration of the area can not be stated. Without essential change of elevation the *Acacia* thickets give way on leaving the limestone, and at 1275 to 1375 meters (4200 to 4500 feet) on a deep loam soil a wholly different type of vegetation is encountered. This is a very open stand of grasses and root perennials with widely spaced shrubs 1.5 to 3 meters high. The three characteristic shrubs of the limestone, *Larrea*, *Flourensia* and *Acacia vernicosa*, are uncommon. The principal large shrubs are *Celtis pallida*, *Prosopis glutinosa*, *Condalia lycioides*, *Cassia Wislizeni*, *Tecoma Stans*, *Mimosa biuncifera* and *Ephedra antisiphilitica*. This is the uppermost type of desert vegetation and merges gradually into a desert-grassland transition similar to that which covers the plains of southern New Mexico. In Chihuahua the desert-grassland transition occupies the plains and bajadas which extend from Moctezuma on the north to the southern boundary of the state; lying above 1525 meters (5000 feet). It also covers the foothills and lower slopes of the barrier ranges, but the conditions there are diversified and the distribution of the vegetation is complex (pl. 2, fig. 1). Along streamways of mountain origin *Quercus Emoryi* descends to 1450 meters (4800 feet) and *Q. chihuahuensis* is sparingly represented on the slopes of the foothills at 1600 to 1775 meters (5250 to 5825 feet). Cacti and yuccas are uncommon but are seen much more frequently than in the upper edge of the desert. On ascending

through the desert-grassland transition there is a gradual increase in the percentage of the surface covered by grasses, particularly on nearly level ground with soil 3 or 4 decimeters or more in depth. The elevation of the lower edge of the grassland is close to 1700 meters (5500 feet) at all localities visited.

GRASSLAND. The grassland of Chihuahua resembles closely that of southeastern Arizona and southwestern New Mexico in its local distribution with respect to topography, in physiognomy, in its dominant grasses and to some extent in the associated non-gramineous plants (pl. 2, fig. 2). At all elevations the prevailing grasses are species of *Bouteloua* (*B. gracilis*, *B. hirsuta*, *B. radicata*, *B. chondrosioides*); which serve to give a striking uniformity to the texture of the plant covering over large areas. In certain places taller grasses form bunches scattered over the sod of *Bouteloua*.

In many parts of the desert-grassland transition there is evidence that grazing has altered the natural vegetation, with a reduction in the amount of grass and an increase in the native weeds *Gutierrezia*, *Aplopappus* and *Verbesina*. Above 1700 meters (5500 feet), however, the continuity of the grass cover, the absence of gullying and excessive erosion, and the scarcity of unpalatable weeds indicates that the vegetation is in a condition close to the natural one. Although the higher grasslands are grazed, it appears obvious that the drain upon them has been light enough for the maintenance of a good self-perpetuating cover under the existing rainfall conditions.

On the upper margins of the grassland valleys a very open oak forest has, in many places, been superposed on the grassland, with little modification of the composition of the grassland except in the shade of the oaks. In such situations a few shrubs are found, being species of more abundant occurrence at somewhat higher elevations. Where extrusions of lava or dykes of other rock occur in the grassland and now lie nearly at accordant level with the surface of the outwash material surrounding them, there is a light and broken cover of grasses (*Andropogon barbinodis*, *A. hirtiflorus*, *Eragrostis mexicana*, *Aristida adscensionis*, *A. divaricata*, *Muhlenbergia Emersleyi*, *Oryzopsis fimbriata*). In such situations there is commonly a very open stand of woody perennials, including stunted individuals of *Quercus Emoryi*, *Q. santaclarensis*, *Juniperus mexicana*, *Mimosa biuncifera*, *Cowania Stansburiana* and *Mimosa dysocarpa*.

When the grassland region is considered as a whole the total number of root perennials associated with the grasses is large. The presence of a particular group of species in a given spot appears to be determined to some extent by the texture and prevailing moisture of the soil, and to a very considerable degree by the chances of seed dispersal and other more obscure conditions. Certain of the associated perennials

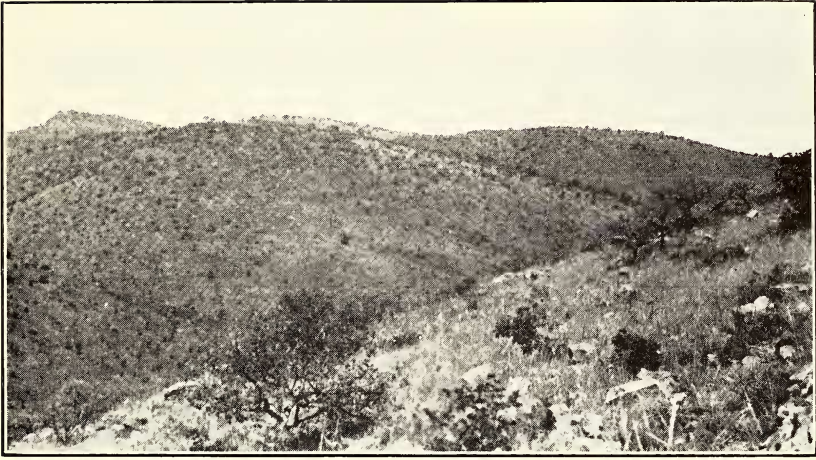


FIGURE 1



FIGURE 2

PLATE 2. VEGETATION OF CHIHUAHUA. Fig. 1. Hills west of Santa Isabel in desert-grassland transition at 1700 meters elevation. The tree is *Quercus chihuahuensis*. Fig. 2. Looking east across grassland in upper drainage of Rio Papigochic at San Isidro in western Chihuahua at 2100 meters elevation.

are of general occurrence while others are abundant in areas of 1, 10 or 100 hectares and rarely seen elsewhere. Many of the perennials are prostrate in habit or low in their mature height, while a number of others reach a height of 6 to 8 decimeters at the time of flowering. About half of the tall species are slender and have leaves either so small in size or so few in number that the plants are inconspicuous. Very few native annuals are found in the region. The great majority of the herbaceous perennials have enlarged roots or rhizomes. The number of species and individuals of bulbous plants is much greater than in the grasslands of Arizona and New Mexico.

The following grassland associates are low or prostrate plants little exceeding the turf of grasses in height:

Brayulinea densa	Tragia nepetifolia
Houstonia Wrightii	Acalypha Lindheimeri
Dyschoriste decumbens	Verbena canescens
Plantago mexicana	Vincetoxicum nummularium
Calliandra humilis	Sisyrinchium tenuifolium
Potentilla Mexiae	Nothoscordum fragrans
Phlox mesoleuca	Oenothera serrulata
Helianthemum glomeratum	

The taller perennials of the grassland include:

Hymenopappus mexicanus	Scutellaria sp.
Petalostemon oligophyllum	Eryngium Wrightii
Thelesperma gracile	Castilleja mexicana
Dalea Grayi	Lupinus Shrevei
Tagetes lucida	Gaura gracilis
Lithospermum cobrense	Erigeron divergens
Linum australe	Ratibida columnaris

Some of the grasses and many of the herbaceous perennials of the grassland are found in the oak forest and even in the lower and more open parts of the pine forest. The upper edge of the grassland is determined by the fact that there is no soil above 2200 meters (7200 feet) which is rock-free, level and not extremely moist.

OAK FOREST (ENCINAL). The oak forest of Chihuahua is found through nearly the same range of altitude as the grassland, which indicates that the climatic requirements of the two are closely similar. The oaks of lowest range, *Quercus Emoryi* and *Q. chihuahuensis*, descend locally into the upper edge of the desert-grassland transition. The oaks of highest range, *Q. hypoleuca*, *Q. pennivenia*, *Q. Sipuraca* and *Q. epileuca*, are associated with the pines at 2150 to 2300 meters (7000 to 7550 feet) and become minor constituents of the pine forest above that elevation.

The distribution of oak forest and grassland throughout their common range of altitude is determined by soil conditions, as